

**Project Title:** SWD in-orchard movement and overwintering population dynamics

**Report Type:** Final Project Report

**Note\*** - This is a winter project. Everything has been offset by one year.

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**Cooperators:**  
M3 Agriculture Technologies

**Project Duration:** 3 Year

**Total Project Request for Year 1 Funding:** \$43,952  
**Total Project Request for Year 2 Funding:** \$41,137  
**Total Project Request for Year 3 Funding:** \$42,254  
**Total Request:** \$127,343

**Other related/associated funding sources:** not funded

**Agency name:** Helium Foundation, IoT grant

**Amount:** \$100,000

**Funding duration:** 2021 - 2023

**Status:** Preproposal approved and highly ranked. Leadership at the foundation changed while in review for the full proposal, and project was not funded.

**WTFRC Collaborative Costs:****Budget 1****Primary PI: Christopher Adams****Organization Name: OSU****Contract Administrator: Charlene Wilkinson****Telephone: 541-737-3228****Contract administrator email address: Charlene.wilkinson@oregonstate.edu****Station Manager/Supervisor: Brian Pearson****Station manager/supervisor email address: brian.pearson@oregonstate.edu**

<b>Item</b>	<b>2021</b>	<b>2022</b>	<b>2023</b>
Salaries <sup>1</sup>	\$21,266.00	\$21,904.00	\$22,561.00
Benefits	\$14,886.00	\$15,333.00	\$15,793.00
Wages			
Benefits			
RCA Room Rental			
Shipping			
Supplies <sup>2</sup>	\$6,800.00	\$2,900.00	\$2,900.00
Travel <sup>3</sup>	\$1,000.00	\$1,000.00	\$1,000.00
Plot Fees			
Miscellaneous			
<b>Total</b>	<b>\$43,952.00</b>	<b>\$41,137.00</b>	<b>\$42,254.00</b>

**Footnotes:**<sup>1</sup>Adams lab Faculty Research Assistant at 0.40 FTE (2 days /wk), with 3% increase in years 2 and 3; OPE 70%<sup>2</sup>Dragino LHT65 temp & humid sensor (\$50 each) x 80, Long Range Transceiver (\$450 each) x2

&amp; Research consumables, SWD bait and traps (40 traps per rep x 3reps = 120 traps) bait replaced weekly for 24 weeks (Jul-Dec) aprox. \$100 x 24 wk = 2400,

<sup>3</sup>Travel to field plots

## Objectives

- 1) Collect micro-climate temperature data and trap for overwintering SWD. (Year 1 beginning fall/winter 2022)

Deviations: Because of an early snow in 2022 we collected very little catch data in the first year.

- 2) Correlate terrain, vegetation and microclimate temperature data with trap counts to determine if specific in-orchard habitats are more favorable to overwintering SWD. (year 2 & 3)
- 3) Determine if overwintering SWD can be targeted with off season sprays or attractive baits. (yr 3)

Deviations: We had planned to target overwintering locations with bait sprays in the 3<sup>rd</sup> year of the project. However, because the early snow fall cut off trapping data in the first year, we would like to first collect two good seasons of trapping data before we attempt to target these populations with a spray. We will plan to target overwintering populations outside the managed orchard, in year four.

Deviation: One of the key orchards was removed this past year and so a replacement orchard will need to be identified. One season of data is probably not sufficient to draw reasonable conclusions. I full 3-year proposal has been submitted to properly address this objective.

## Significant findings

- We established 4 orchard blocks in The Dalles and installed 20 remote temperature and humidity sensors in each, with wireless a network, paired with 20 insect traps. (Figure 2). We were able to successfully collected a grided network of hourly temperature data across these orchards and transmit that data to the cloud for remote data collection.
- Winter micro-climate temperatures are not correlated with SWD catch data.
- Elevation was not correlated with higher overwinter SWD catch data.
- The specific habitat (oak or conifer) was not correlated with higher SWD catch data.
- Snow cover (not cold weather) significantly affects SWD winter catch data (SWD activity).
- In year two we saw a pattern in all four orchards. Large numbers of SWD are present throughout managed orchards in late fall (October). By early November, the majority of catch data is recorded in traps just outside the border of the managed orchard, in oak or pine habitats. In some cases, “habitat” might just be 2 or 3 pine trees.
- It is not clear if SWD are *surviving* better in off-site habitats (reproducing) or if they are *moving* to these habitats for shelter or food.
- There is a larger SWD population in the off season than during the growing season. This means that sprays applied at this time would produce a much greater return on investment (kills per dollar) than sprays applied during the growing season. Attract and kill strategies could be extremely impactful to SWD populations. A full 3-year proposal has been submitted to address this question.
- Erythritol (non-sugar sweetener) was applied as a non-pesticide winter control tactic in a separate un-funded on-farm field trial in The Dalles. Results were inconclusive. We plan to look at Combi-ProTec in combination with a pyrethroid or OP in subsequent experiments.

## Brief Overview

The inspiration for this research came from visiting an orchard in The Dalles (Figure 1) and observing that there were no wild resources outside of the managed cherry orchard. The conventional wisdom is that SWD leave cherry orchards after harvest to find suitable overwintering sites. In addition, this area experiences high winds most of the year, so flies might struggle with directed migration, and might need to seek shelter in place, alternatively we might see catch increase in downwind populations. At the center of the orchard is a valley with some wild blackberry habitat. Our hypothesis was that overwintering SWD would move to the valley at the center of the orchard to seek shelter for the winter, or find microclimate locations with favorable conditions. To capture the microclimate across the orchard we partnered with M3 Agriculture Technologies to equip the orchard with 20 temperature and humidity readers and connected them to a central hub modem with cell phone connectivity for remote data access (Figure 1). Each temperature reader was paired with a baited trap. While catch data from the traps in the valley was the highest (>4000), other traps still caught SWD at very high levels (1000s). This would suggest that flies are not moving out of the orchard, but are seeking shelter within the orchard. How and where SWD overwinter, and what environmental conditions SWD need to survive is still unclear. Many questions remain to be answered about winter movement. This project was designed to expand this initial research project to three other orchards and try to replicate these results, to understand winter survival of this important invasive species.

## Methods

1. Collect micro-climate temperature data and trap for overwintering SWD.

*Site selection.* In fall of 2022 four orchards were equipped with an array of temperature and humidity sensors and a central solar powered modem to collect and transmit data. Each temperature sensor was paired with a baited (apple cider vinegar and wine) cup trap. Traps were deployed in a grided pattern across each block, with the last row of traps on a border (where possible) outside the orchard.

*SWD data collection.* Traps were checked weekly or bi-weekly (every other week) from October through February in 2022/2023, and 2023/2024. Because of the volume of traps (80 traps spread across The Dalles) SWD numbers were estimated\* when catch in the traps was high, e.g. above 100 (\*note even numbers in catch data on maps of Fig.2). SWD parasitoids were also collected when they got caught in monitoring traps.

*Temperature monitoring.* Remote Sensors collect temperature and humidity data hourly and send data to the cloud for storage (Figure 1)

2. Correlate terrain, vegetation and microclimate temperature data with trap counts to determine if specific in-orchard habitats are more favorable to overwintering SWD. (year 2 & 3)

*Data analysis.* We tried to find correlation of temperature, humidity, elevation, and habitat with SWD trap catch data. Only habitat was correlated with high late season trap catch data.

3. Determine if overwintering SWD can be targeted with off season sprays or attractive baits.

*Insecticidal trails.* Bait sprays will be applied in year four after (we hope) we see two consecutive years of catch data to document overwintering locations in all four blocks.

## Results and Discussion

SWD catch data showed a similar pattern in most orchards (Figure 2). Traps hung at the edge of the blocks in pine, cedar, or along oak fragment habitat caught more flies in late winter. Often the catch in these border traps was in the thousands in November and December. In some cases, the “outside orchard” habitat was just a couple of pine trees within the larger orchard. A severe cold snap in January of 2024 did not completely shut down catch of SWD; catch followed a downward trend, but we still saw catch data in February (Figure 4). Snowfall *did* completely shut down all catch in traps early in the fall 2022.

There was some difference in catch data between orchards, with some blocks still catching hundreds of SWD in the interior of the block, while others dropped to zero within the cherry trees. Elevation and micro-climate humidity and temperature were not correlated with high catch data. High catch within the trapping grid did not correlate with prevailing winds at any of the locations.

Orchards 2, 3, and 4\* had no other wild berries in the orchard or in the surrounding outside orchard habitat (\*orchard 4 has a personal raspberry planting. A trap placed at this location was not the highest catching trap of that block). Orchard 1 had extensive wild Himalayan blackberry throughout the orchard that was *all* removed in the winter/summer of 2022, and currently has no more fruiting (non-cherry) food sources for SWD in or around the orchard. With no outside habitat the possibility for completely eliminating SWD in this isolated orchard seems possible.

We do not have any data to understand if flies are *moving* from the interior of the orchard to the pine or oak habitat, where we get thousands of flies in the monitoring traps in November and December. However, there are no resources within the orchards post-harvest, other than a handful of fallen cherries. SWD has a *winter morph*, which is a slightly different physical form that is more robust looking, and designed to over-winter. This winter-morph is thought to suppress reproductive activity, slow its metabolism and simply *survive* the winter. We do not know how the population goes from near zero (most monitoring traps in Wasco Co. catch zero during June, July, and August, see Fig. 5) to the thousands we find in November. It is likely that flies are reproducing across the landscape in non-cherry fruit such as Himalayan blackberries.



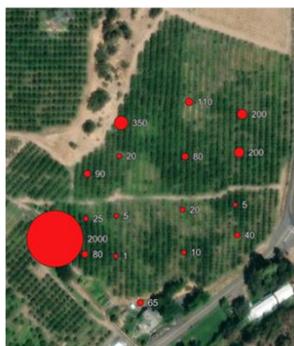
Figure 1. SWD trap, temperature sensor, and solar panel powered modem for data collection.



Orchard #1 – 11/21/2023



Orchard #2 - 12/9/2023



Orchard #4 – 11/27/2023



Orchard #4 – 11/13/2023

Figure 2. Catch data in the four orchard blocks in late November and early December of 2023. Red dots indicate locations of temperature sensors and SWD traps. Size of the red dots is relative to catch data. Numbers indicate estimated catch for the week. Blocks are between 5 and 10 acres with elevation change of 5 – 20 meters.



Figure 3. Visualization of hourly temperature data across block #4, showing variable temperatures (in °C) across the orchard. Micro climate temperature and humidity did not correlate with increased SWD catch in traps.

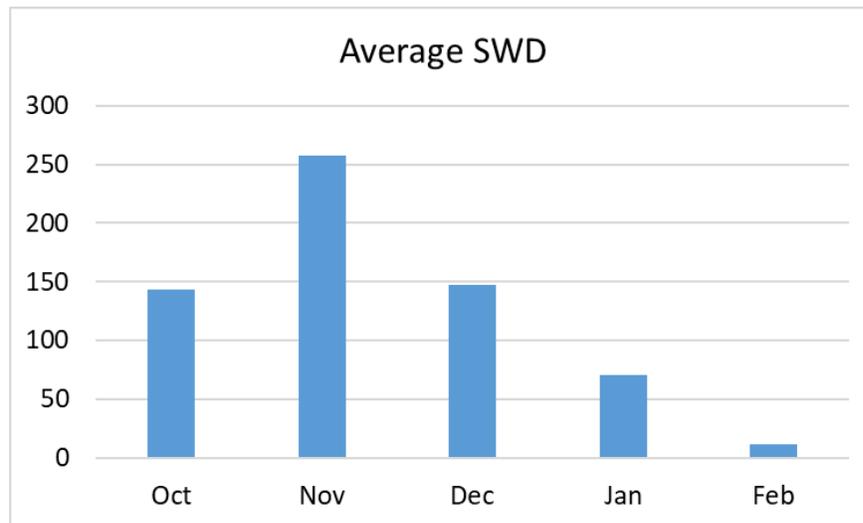


Figure 4. Winter 2023/2024, average catch per trap across all four sites (n = 80 traps) by month. The graph shows peak catch of SWD is in November. This indicates when a pesticide spray or an attract and kill bait would be most effective. This indicates where the control tool would need to be effective, not necessarily when it would need to be applied. For example, an attractive bait applied in September would need to still be viable and effective in November and December to target peak winter populations.

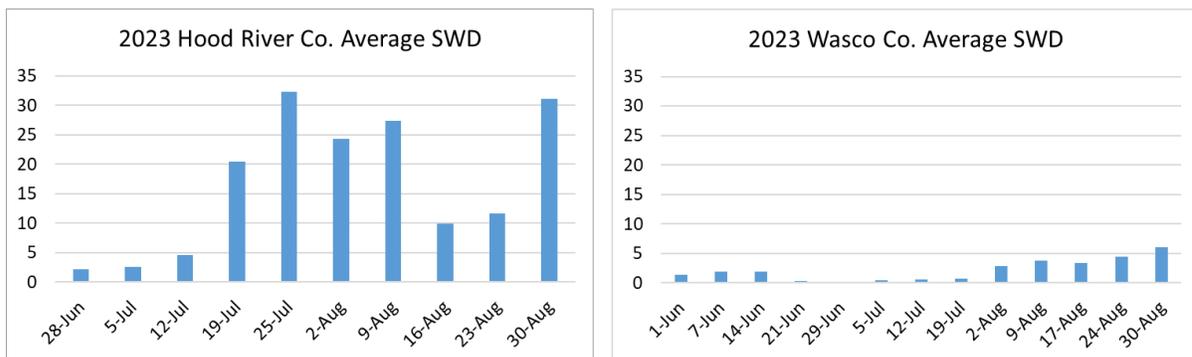


Figure 5. Summer 2023 average catch per trap data across our trapping network in both Hood River and Wasco counties. Data shown for comparison to winter catch (Figure 4). Prophylactic protective sprays are necessary when fruit is present on the trees and *must* be applied regardless of catch in monitoring traps. However, control tactics targeting off-season SWD could be much more impactful and possibly reduce the pressure/population in the following season much more than in-season sprays.